Medical Preparedness for a Terrorist Incident Involving Chemical or Biological Agents During the 1996 Atlanta Olympic Games

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Received for publication July 11, 1997. Revisions received October 2, and October 17, 1997. Accepted for publication January 1, 1998.

During the 1996 Centennial Olympic Games in Atlanta, Georgia, unprecedented preparations were undertaken to cope with the health consequences of a terrorist incident involving chemical or biological agents. Local, state, federal, and military resources joined to establish a specialized incident assessment team and science and technology center. Critical antimicrobials and antidotes were strategically stockpiled. First-responders received specialized training, and local acute care capabilities were supplemented. Surveillance systems were augmented and strengthened. However, this extensive undertaking revealed a number of critical issues that must be resolved if our nation is to successfully cope with an attack of this nature. Emergency preparedness in this complex arena must be based on carefully conceived priorities. Improved capabilities must be developed to rapidly recognize an incident and characterize the agents involved, as well as to provide emergency decontamination and medical care. Finally, capabilities must be developed to rapidly implement emergency public health interventions and adequately protect emergency responders.

[Sharp TW, Brennan RJ, Keim M, Williams RJ, Eitzen E, Lillibridge S: Medical preparedness for a terrorist incident involving chemical or biological agents during the 1996 Atlanta Olympic Games. *Ann Emerg Med* August 1998;32:214-223.]

INTRODUCTION

The 1996 Centennial Olympic Games in Atlanta, Georgia, focused national attention on the need for an effective medical response to a terrorist attack involving chemical or biological agents. The country had just experienced a series of highly visible and destructive terrorist attacks with conventional weapons, including the bombing of the Federal Building in Oklahoma City. The chemical attack with the nerve agent sarin in the Tokyo subway system in March 1995 had demonstrated both the extensive social disruption that can ensue from a terrorist attack involving chemical weapons and the complexities involved in mounting an effec-

tive medical response.[1-4] The use of biological agents as weapons of terrorism was regarded as having the potential to cause tens of thousands of casualties and to cost billions of dollars to the US economy.[5-9] With more than 10,000 athletes, 2.2 million visitors, and 35 heads of state expected in Atlanta for the Olympic Games, and approximately 2 billion persons expected to watch on television, the possible implications of a terrorist incident, particularly one involving chemical or biological agents, were profound.[10-14]

An addition to the Federal Response Plan that described the national response to a chemical or biological incident was developed before the Olympic Games by the Office of Emergency Preparedness of the Department of Health and Human Services.[15] This plan defined roles and responsibilities for the health response on the federal level. Before the Atlanta Olympic Games, however, only certain specialized units within the military and the law enforcement communities were prepared to cope with chemical or biological agents. The literature that dealt with protecting the public health at large events did not address terrorism or these agents in any detail.[16,17] There was no single plan or organization to guide response preparations. The city of Atlanta had little indigenous capability to recognize or deal with terrorism involving chemical or biological agents. Efforts undertaken to cope with chemical or biological terrorism for the Olympic Games were therefore the result of the federal plan plus the diverse initiatives of many organizations and agencies from both within and outside of the city.

Extensive preparations were undertaken in Atlanta to meet the expected demand for health services in the hot summer conditions of the Games. These included establishment of a system of medical clinics for athletes and visitors; enhancement of public health support, particularly regarding food safety and prevention of heat illness; augmentation of EMS systems; and disaster response planning.[18-20] In addition, extensive and unprecedented efforts were undertaken involving local, state, federal, and military resources to prepare Atlanta for the medical consequences of chemical or biological terrorism. In this article, we highlight some of the many complex issues with which the nation is faced in trying to develop an effective medical response to this threat.

PREPARATIONS IN ATLANTA

Specialized assessment team

An assessment team for chemical and biological terrorism was established by Federal Bureau of Investigation (FBI) scientists and placed on 24-hour call at the start of the Olympic Games.[21] This team's mission was to proceed by helicopter to conduct a rapid assessment of an incident site, collect critical evidence, and assume command and control of the scene from local first-responders. The FBI team included military ordnance disposal experts and personnel from the US Army Technical Escort Unit. This unit, which was formed during World War II to transport the first atomic bomb, specializes in identification and safe transport of weapons of mass destruction. Their role was to make a preliminary identification of any chemical or biological agents (Table 1) and to transport samples out of the area for definitive analysis.

The FBI assessment team also included military physicians with extensive training in the identification and management of patients exposed to chemical or biological agents. These physicians were available to evaluate the presentation of any affected persons and correlate clinical findings with any other available information, such as readings from rapid chemical agent detector devices.

Science and technology center

A Center was created at the Centers for Disease Control and Prevention (CDC), which was conveniently located in Atlanta, to provide emergency public health, medical, toxicologic, forensic, and scientific consultation after a suspected terrorist event involving chemical or biological agents.[22] The Center was closely linked with the FBI assessment team and included representatives from a number of the environmental and infectious disease laboratories at CDC, the Agency for Toxic Substances and Disease Registry, and the military. The Center also had representatives from the local public health and emergency medicine commu-

Table 1.
Examples of chemical and biological agents that could be used in a terrorist attack.

Category	Examples
Military chemical agents	
Nerve agents	Sarin, soman, tabun
Blister agents	Mustard compounds, lewisite
Choking agents	Phosgene, chlorine
Incapacitating agents	Phenothiazines, BZ
Blood agents	Hydrogen cyanide
Industrial chemicals	
Organic compounds	Dioxin, organic acids
Pesticides	Methyl isocyanate
Toxic gases	Ammonia, chlorine
Biological agents	
Bacteria	Anthrax, tularemia, plague
Viruses	Viral hemorrhagic fevers, smallpox
Toxins	Botulinum, ricin

nities to provide additional expertise and to help ensure an integrated emergency response.

A US Army laboratory team that monitors international chemical weapons treaties established a mobile laboratory at the Center that was equipped with gas chromatography, mass spectrometry, and other advanced technologies to definitively identify chemical agents, particularly military chemical agents such as the nerve, blister, incapacitating, and blood agents. A unit from the Naval Medical Research Institute in Bethesda, Maryland, which had a number of technologies for the rapid identification and confirmation of biological agents, established operations in the Center. This unit had recently developed handheld assays, confirmatory polymerase chain-reaction assays, confirmatory immunoassays, and culture techniques to rapidly identify *Bacillus anthracis*, botulinum toxin, *Francisella tularensis*, *Brucella melitensis*, and other biological warfare agents. The US Army Research Institute for Infectious Diseases stood by to provide additional specialized laboratory support if necessary.

The Defense Special Weapons Agency provided a team with the capability of preparing a computer simulation to predict the dispersion plume of any released chemical or biological agents. The Food and Drug Administration sent a liaison team to help identify and deal with foodborne and waterborne agents or product adulterations. An Environmental Protection Agency Emergency Response Team was assigned to the Center to provide a capability to enter a site where there is a known or unknown industrial chemical agent, identify the compound, delineate the hazard area, and begin mitigation of the environmental contamination. A US Coast Guard National Strike Force, a unit with similar capabilities, was also present.

Stockpiling and distribution of antimicrobials and antidotes

Drugs appropriate for the treatment of patients exposed to chemical and biological agents were stockpiled by the Veterans Administration at Dobbins Air Reserve Base, just north of Atlanta. The quantities assembled were based on an arbitrary estimate for planning purposes of 10,000 casualties with 10% to 15% of these casualties requiring tertiary care. (Military estimates assume that 6% to 10% of similar casualties on the battlefield will require tertiary medical care.) Stockpiled drugs included antimicrobials for the treatment of biological agents and antidotes for chemical agents (Tables 2 and 3). In the event of a suspected attack, supplies of the appropriate medications would have been transported rapidly by road or helicopter to health facilities throughout Atlanta.

Because treatment must be given very soon after chemical agent exposure, additional supplies of chemical agent antidotes were distributed to local hospitals. Nerve agent antidotes and cyanide kits were included in chemical agent treatment packs that were provided to selected emergency responders. Antimicrobials were not provided to hospitals before the Games because the incubation period of infectious agents and the slower onset of clinical symptoms would have allowed time for distribution of needed drugs to appropriate locations. Similarly, emergency responders were not provided with antimicrobials in their emergency treatment packs.

Specialized training for first-responders

Before and during the Games, approximately 1,700 fire department, police, hazardous material response team, emergency department staff, and other prehospital response personnel in Atlanta, as well as other host cities (Miami, Athens, Birmingham, Orlando), attended a variety of seminars and courses on chemical and biological agents. Course curricula were either modified from existing US Army courses[23,24] or were developed for the Olympic Games by local physicians. The courses typically involved an overview

Table 2.
Antimicrobials stockpiled in Atlanta during the 1996 Olympic Games, and the diseases against which they are effective.

Antimicrobials	Diseases
Ceftriaxone injection	Salmonella, typhoid
Ciprofloxacin injection	Anthrax
Ciprofloxacin tablets	Anthrax, salmonella, shigella, plague
Doxycycline capsules	Brucellosis, cholera, plague (prophylaxis), Q fever, tularemia
Penicillin G injection	Anthrax
Streptomycin sulfate injection	Brucellosis, plague, tularemia

Table 3.
Chemical agent antidotes and treatments stockpiled in Atlanta during the 1996 Centennial Olympic Games, and the chemical agents against which they are effective.

Antidote	Chemical Agent
Atropine sulfate injection	Chemical nerve agents
Diazepam injection	Chemical nerve agents
Pralidoxime injection	Chemical nerve agents
Diazepam autoinjector (provided to emergency responders)	Chemical nerve agents
Atropine-pralidoxime autoinjector (provided to emergency responders)	Chemical nerve agents
Cyanide antidote kit	Cyanide

of the major potential chemical and biological agents and associated clinical syndromes and instruction in the use of personal protective equipment, decontamination procedures, and therapeutic strategies, including use of antidotes and antimicrobials. Many first-responders procured commercially available chemical agent detection equipment, additional treatment modalities, personal protective gear, and decontamination equipment. The Atlanta Poison Control Center developed and disseminated special information on treatment of persons exposed to military chemical agents. Many emergency response organizations, such as hospital EDs and hazardous materials response teams, conducted exercises and drills that involved simulated casualties from a chemical or biological attack.

Enhanced surveillance

Two complementary public health surveillance systems were established specifically for the Olympic Games by local and state health authorities in conjunction with CDC to detect outbreaks requiring a public health response. These systems built on the preexisting passive surveillance system for notification of infectious diseases and other significant conditions in Georgia.[18] The first system focused on athletes and spectators in the Olympic Village and the 25 Olympic venues, and the second focused on local hospitals. Standardized data from patient encounters were transmitted on a daily basis to a surveillance coordination center, where they were compiled, summarized, and reported promptly to state and federal officials. Reports from the state public health laboratory and the state's major private medical diagnostic laboratory were also transmitted on a daily basis to the surveillance center. Additionally, local physicians were encouraged through various announcements and newsletters to promptly report any unusual clinical presentations to the Georgia Division of Public Health.

Identification of a terrorist incident involving chemical or biological agents was not the goal of these systems; they were primarily designed to detect heat illness, foodborne outbreaks, and other more routine public health problems. However, they provided a critical means of detecting an insidious attack with a chemical or biological agent. If an outbreak of any type had been detected, the investigation and response could have been augmented rapidly by Epidemic Intelligence Service officers from CDC or the Science and Technology Center.

Augmented clinical capabilities

A US Marine Corps unit that was created just before the Olympic Games, the Chemical Biological Incident Response Force, was stationed and on alert in downtown Atlanta near the major competition venues.[25,26] This unit had the capability to rapidly send Marines and medical personnel equipped with personal protective gear into a contaminated area to provide emergency triage, stabilization, decontamination, and evacuation of exposed persons. No other organization in Atlanta had this capability.

Thirty Public Health Service Disaster Medical Assistance Teams (DMATs)[27] from throughout the United States were rotated through Atlanta over the course of the Games. For this occasion, basic DMATs were modified to consist of a physician, a physician's assistant, a nurse, and two EMTs. The teams developed portable treatment packs with essential medications and supplies. Most DMATs were on call at Dobbins Air Reserve Base and stood by ready to deploy to a disaster site by helicopter. Some were stationed in major hospitals around Atlanta. DMAT personnel received special training in the management of casualties of a chemical or biological attack, principally from physicians from the US Army Medical Research Institutes for Infectious Diseases and Chemical Defense. In the event of a chemical or biological incident, DMAT personnel were to augment local care providers and provide a link between the Marine Corps unit and local fixed medical facilities.

Members from one of a group of federal response teams currently under development, the Metropolitan Medical Strike Teams, which are intended to be rapidly available medical units stationed around the country to deal with chemical and biological agents,[15] were also present. A number of other military units were standing by in the southeastern United States to augment local response efforts if necessary.

DISCUSSION

Almost all of the major federal and military organizations in the United States that would have had a role in responding to a chemical or biological terrorist incident were deployed to Atlanta during the Olympic Games. Before this time, few of these organizations had ever collaborated to respond to a terrorist action, nor had many worked with local emergency response personnel. The Games served as an unprecedented opportunity to develop and refine integrated response plans through daily interactions, formal planning sessions, tabletop exercises, conferences, and field exercises.

In addition, on the 10th day of the Games a terrorist bomb was detonated in Centennial Park. This bomb was judged by first-responders not to involve chemical or biological agents. Members of the FBI specialized assessment team evaluated the situation as a precautionary measure, and samples from the scene were transported to the Science and Technology Center for analysis. Testing of bomb fragments confirmed within a few hours that no chemical or

biological agents were involved. Although most of the organizations described here did not become involved in the response to the bombing, this incident served in some respects to test the preparations that had been made to recognize and cope with chemical or biological agents.

The preparations for the Games, and the actual detonation of a bomb, demonstrated that although there are many sophisticated capabilities available in the United States, there are still many difficult problems to be solved if we are to have an effective capability to manage the health consequences of a chemical or biological incident at the local level. Some of the most significant issues that emerged are described in the following sections.

Establishing priorities for medical preparedness

Although predicting the location and nature of a terrorist attack is difficult and perhaps impossible,[28-31] rational articulation and prioritization of potential threats is essential for effective planning. Critical aspects of preparedness that rely on a medical threat assessment include the placement of necessary treatment drugs in medical facilities and the provision of appropriate training to prehospital responders and other medical personnel. Also, the cost of preparations is a critical factor. With limited resources to deal with the various chemical and biological threats, assets invested in this area should be appropriate to the magnitude of the various threats and must be balanced against competing health priorities.

In Atlanta, there was considerable discussion of potential threats, and law enforcement and intelligence agencies identified and tracked potential terrorists. However, a well-conceived and prioritized medical threat list was not readily available for emergency health responders. Consequently, as preparations evolved, most organizations focused on the management of a single discrete terrorist event involving military chemical agents, particularly nerve agents (Table 4). This approach probably was influenced by the recent sarin attack in Tokyo. Also, most of the detection equipment, training, and procedures that were available had been developed by the military to deal with military chemical agents on the battlefield.[23,24]

However, Atlanta has many major manufacturing industries that receive by rail and truck approximately 100,000 shipments per year consisting of 30,000-gallon tank cars containing hazardous materials. Many of the major transportation routes pass through downtown Atlanta, with many routes near the Olympic venues. Relatively little effort was made to identify and prepare for incidents involving these industrial chemicals, such as ammonia or chlorine gas.[32] Also, possible biological scenarios were not well developed,[33,34] and a response plan to a biological attack was not well delineated. Of note, although the sarin attack received much publicity, the Aum Shinrikyo group had also previously attempted to disseminate anthrax spores and had attempted to obtain Ebola virus.[35]

Data on the total cost of the response effort that dealt with chemical and biological terrorism are not available. The units enumerated here, not including Atlanta-based personnel, involved the deployment of approximately 1,000 people. Deployment of the Marine Corps unit alone cost approximately $7 million. In few other situations will potential responders have access to the extensive resources that were available for the Olympic Games.

Members of the Science and Technology Center, together with additional consultants from the fields of toxicology, infectious diseases, and nuclear physics, met during the Games to develop a prioritized list of the most likely terrorist scenarios. According to these deliberations, terrorists may have been more likely to take advantage of accessible industrial chemicals rather than the technologically more

Table 4.
Time-line of the planned response to a terrorist incident involving chemical agents during the Atlanta Olympic Games, 1996.

Response Time	0–20 min	20–40 min	>40 min	2–6 hr
Emergency responders	Police, fire department, EMS, HAZMAT units	FBI assessment team, CBIRF, local hospitals	DMATs, EPA ERT, USCG ST	Army teams, EPA, ATDSR, FDA
Command and control	Local authorities	FBI	FBI/FEMA	FEMA/FBI
Agent identification	Observational reports	Field assays	Samples sent to labs	Definitive identification
Public health actions	Situation assessment	Public warnings, decontamination, evacuation	Antidote stockpiles distributed, technical consultations initiated	Long-term strategy developed

HAZMAT, local hazardous materials response teams; **CBIRF,** US Marine Corps Chemical Biological Incident Response Force; **DMAT,** US Public Health Service Disaster Medical Assistance Teams; **EPA ERT,** Environmental Protection Agency Emergency Response Team; **USCG ST,** US Coast Guard Strike Team; **EPA,** Environmental Protection Agency response elements; **ATDSR,** Agency for Toxic Diseases and Substances Registry response elements; **FDA,** Food and Drug Administration emergency response team; **FEMA,** Federal Emergency Management Agency.

complex military chemical or biological agents (Figure). Although such a priority list does not predict what a particular terrorist organization will do, it might have been useful earlier in the planning processes to provide guidance for those trying to plan for the most likely threats and appropriately allocate limited medical resources.[36]

Recognizing an incident and rapidly characterizing the agent

A fundamental assumption of local response plans was that first-responders would recognize that a chemical or biological agent had been used. However, the use of such agents might not have been readily apparent, particularly if the attack involved a biological agent.[6,8,13,33]

Because anthrax spores are invisible and can be disseminated by means of inexpensive, commercially available spray devices, the first indication of an anthrax attack would probably have been when exposed persons began to develop characteristic clinical symptoms. Anthrax initially causes a nondescript, influenza-like illness 2 to 3 days after exposure, with clinical deterioration and characteristic symptoms occurring a few days later.[6] Patients would have presented in diverse locations throughout Atlanta, and probably remotely from Atlanta as well. In time, diagnoses of anthrax would have been made and an outbreak identified, but probably not until well after the attack.

Attempts to verify allegations of the use of chemical or biological agents, such as the alleged "yellow rain" in southeast Asia and the use of anthrax as a weapon in Zimbabwe, have revealed many of the potential difficulties that can be encountered in a retrospective investigation.[33,37-40] Although the investigation of anthrax cases in Atlanta would have been straightforward once the agent was identified, other infectious agents occur naturally in Atlanta, and differentiating a "natural" from an "unnatural" outbreak and conclusively identifying modes of spread could have been very difficult.

The Centennial Olympic Park bombing showed that even in an overt incident, emergency response units did not have standard observational criteria or screening procedures to help determine whether the attack involved chemical or biological agents. This determination relied solely on the suspicion of first-responders. Although the appearance of a cloud of gas is obvious, biological or radiologic contamination may not be evident. In the Centennial Park incident, bomb fragments ultimately were collected on an ad hoc basis and shown by the Science and Technology Center not to contain any chemical or biological agents. However, criteria for recognizing an attack and a standard approach to sampling would have been useful.

If the use of a chemical or biological agent had been suspected, definitive identification of the agent or agents used would almost certainly have occurred in time. The Science and Technology Center had extensive state-of-the-art capabilities to identify virtually any biological agent or chemical compound. Furthermore, arrangements were in place to send samples to cooperating laboratories with experience in these areas, such as the US Army Medical Research Institute for Infectious Diseases in Fort Detrick, Maryland. However, given the time needed for the collection and safe transport of samples, and then to perform necessary confirmatory tests, definitive identification would have taken at least several hours, or possibly even several days in the case of a biological agent.[8,33]

Rapid on-site identification of an agent, on which many early interventions would have depended, may have been problematic. Many responders relied on military equipment such as the handheld Chemical Agent Monitoring System, which is a device designed to identify known military chemical agents.[23,24] If one of the standard military agents had been used in an attack, it most likely would have been detected on-site by these devices. However, currently available information suggests that military rapid detection equipment has high sensitivity but low specificity and is therefore prone to false-positive readings.[24] (Exact performance characteristics of this equipment are classified.) In addition, it is not clear how well current military rapid detection technologies would have performed in identifying variants of the currently known military agents or new chemical agents. Recent reports suggest that the Russian government may have developed new types of nerve agents that are not readily detectable with current technologies.[41]

Rapid identification of an unknown industrial chemical can be a complicated process.[42] A wide variety of technologies are under development to rapidly identify biological agents in clinical and environmental settings. However, biological detection technologies, most of which are in research and development, still have limitations. These systems have

Figure.
Most likely methods of terrorist attack in order of the threat, as determined by the Science and Technology Center at the Centers for Disease Control and Prevention during the Centennial Olympic Games, Atlanta, Georgia, 1996.

1. Use of a conventional explosive
2. Release of an industrial chemical agent
3. Release of a military chemical agent
4. Use of a conventional bomb laced with chemical, biological, or radiologic agents
5. Release of a biological agent
6. Detonation of a nuclear device

been difficult to develop, and capabilities exist at present to identify only certain biological agents, primarily those deemed to be of military importance, such as anthrax and botulinum toxin. The performance characteristics of these technologies are not yet well established.[43]In addition, no matter what detectors are available, rapidity in identifying an agent may depend on clinical evaluation and on correlation of observed signs and symptoms with other information, such as findings from rapid detectors. Only the FBI specialized assessment team had clinicians who were experienced in identifying signs and symptoms of exposure to chemical and biological agents.

Providing appropriate decontamination and medical care to exposed persons

Assessments of the ability of military and civilian medical personnel to recognize and manage cases of exposure to chemical or biological agents invariably emphasize that appropriate training and practice exercises are required.[8,13,42-45] Although some medical training was undertaken in Atlanta, most health care professionals had only a brief introduction to chemical and biological weapons, or no training at all.

A fundamental concern was the medical management of contaminated patients,[46,47] particularly those exposed to chemical agents. Persons exposed to biological agents generally require little decontamination. For an incident occurring in downtown Atlanta and involving a relatively small and contained number of casualties, the Chemical Biological Incident Response Force was well placed and prepared to decontaminate and stabilize approximately 100 exposed persons. However, had there been a larger number of chemical casualties, or casualties in more remote and dispersed locations, most emergency response personnel, DMATs, and health facilities had very limited means to decontaminate exposed persons. Most local hospitals, for example, had the capability to decontaminate only one or two patients at a time. In the event of deaths, mortuary facilities had little or no means to handle contaminated bodies.

Even after a small, discrete event, some people would almost certainly have sought care directly at local health care facilities. After the sarin release in the Tokyo subway, the majority of those exposed who were ambulatory bypassed the local EMS and sought care directly in a multitude of medical facilities.[1-4] As a result, some health care workers in Tokyo were symptomatic after being exposed secondarily to sarin vapor. If patients had had traumatic wounds with deep contamination, which are very difficult to decontaminate, there would have been no means to provide more than emergency interventions in the field without risking contamination of hospital facilities.

The provision of medical care within a site contaminated by a chemical or biological agent also raises many difficult questions.[48] Current military doctrine is to maintain almost all medical care capability in an uncontaminated area where clinicians are safe from exposure and do not have to work in cumbersome personal protective gear.[23,24] This may be appropriate for battlefield conditions; however, decontamination of exposed persons and their evacuation to uncontaminated areas can be a prolonged process, especially for exposures to chemical agents, and some may require antidotes or other interventions urgently (eg, airway management).

The Chemical Biological Incident Response Force worked to develop and refine procedures to send skilled health care professionals and enhanced treatment capabilities (eg, portable respirators) into a contaminated area.[25,26] They also acquired telemedicine technologies, such as a small helmet-mounted microphone and camera which would have allowed real-time visual and audio communications with health care providers in the contaminated area. However, procedures for providing care in a contaminated zone and algorithms for providing care to contaminated patients were not yet developed by the time of the Games. In addition, triage criteria for patients exposed to a chemical or biological attack were not defined. Difficult ethical and legal questions, such as whether emergency responders not licensed to administer medications should be permitted to provide emergency treatment to persons in a contaminated area, were also unresolved.

Developing and implementing emergency public health interventions

In addition to the problems of providing acute care to the exposed, a number of public health issues would almost certainly have arisen after any agent release.[47-51] The prospect of coping with mass exposure to anthrax spores, for example, is daunting. The appropriate use of prophylactic antibiotics, immunizations, quarantine, isolation, and other measures to minimize or prevent further exposures and illness would have been complex and critical concerns.[6]

After the sarin release in Tokyo, the majority of those seeking medical care did not exhibit any clinical signs or symptoms.[1-4] Therefore, had there been a chemical or biological emergency in Atlanta, protocols for screening those who appeared well but might have been exposed would have been necessary. If a cloud of gas had been released and immediately detected, urgent decisions on whether to attempt evacuation or to rely on sheltering in place also

would have been needed. Complex and sensitive issues regarding containment and cleanup of an agent also would have been critical concerns; many questions would probably have arisen regarding air quality, food safety, animal exposures, and residual soil or water contamination.

A rapid epidemiologic investigation documenting exposures and health outcomes would have been important during the immediate response period to facilitate identification of the agent or agents used, to identify exposed persons, and to develop appropriate curative and public health interventions.[49] Long-term epidemiologic surveillance, including the establishment of disease and injury registries, would have been necessary to guide appropriate follow-up of exposed persons, to develop long-term control measures, and to analyze the response effort.[52]

Protecting emergency responders

Providing emergency medical response safely in an environment where chemical or biological agents have been used mandates careful attention to safety procedures. Even then the response may involve substantial risks.[53,54] In responses to hazardous materials incidents, there must be an overall site safety manager with ultimate authority to ensure safety. For the Olympic Games, although safety was certainly a major concern for responders, it was uncertain who, if anyone, would have assumed this critical oversight role at an incident site. Military units in Atlanta were equipped primarily with battlefield self-protective gear (Saratoga suits and M-40 masks), which are designed to protect troops against military chemical agents and biological agents on the battlefield, rather than more fully protective suits.[23,24] This gear would not have provided protection against exposure to some industrial chemicals, particularly gases. Whatever the protective suit used, the ambient temperature and humidity in Atlanta typically were greater than 90° F and 90%, respectively. Working in protective gear for more than about 30 minutes risked serious injury from heat illness. Recently developed cooling vests were found to be practical and to prolong safe work times somewhat,[54] but during exercises and drills responders had to work slowly, consume large quantities of fluids, rotate out often, and be monitored closely for signs of heat stress.

Chemoprophylaxis and immunoprophylaxis measures did exist for responders who conceivably could have been exposed to chemical or biological agents during a response. Survival after exposure to certain nerve agents is improved substantially by the prophylactic use of pyridostigmine.[55,56] Safe and effective immunizations exist for some potential biological agents, such as anthrax and botulinum toxin. However, no immunization or chemoprophylaxis programs were implemented by responders in Atlanta. Whether such programs were needed, and if so how they should have been used, were unresolved issues. Of note, pyridostigmine and most relevant immunizations, with the exception of anthrax vaccine, remain in investigational new drug status for these indications.

In Atlanta, emergency health responders were not supposed to enter an incident site until the crisis was resolved and the scene was considered safe. However, after an incident, particularly one involving chemical agents, there probably would have been substantial pressure to provide immediate emergency care to victims, which could have placed responders at risk.[57]

Emergency response operations and coordination

The sequence of events that would have ensued after a discrete incident was well planned out by the conclusion of the Games. In sum, the first-responders to an incident, local fire department personnel and police, would promptly have notified their superiors through the appropriate chains of command if they suspected a terrorist incident involving chemical or biological agents. Emergency support operations on the local, state, and federal levels would, in turn, have been activated, and the organizations enumerated here would have been mobilized. However, the presence of many organizations from different jurisdictions created confusing and sometimes conflicting chains of command. In addition, had there been an occult attack involving biological agents, or attacks in multiple locations, it is not clear how the response would have evolved. Some response units had different, and incompatible, communications gear. Local telephone services, which were taxed by the large number of visitors and media personnel, would have been overwhelmed. Dedicated communications networks were unavailable for some of the local hospitals that might have received the majority of the patients.

RECOMMENDATIONS

Our experience in Atlanta showed that an effective response to terrorism involving chemical or biological agents is complex and multifaceted. In the event of a terrorist incident involving such agents, effective management of the consequences would have to involve a rapid and coordinated response from local, state, federal, and military agencies. Based on the Atlanta experience, we present the following general recommendations and observations to guide future preparedness and response activities. Although the Atlanta experience was unique in many respects, we believe that these principles have broad application.

• Preparations for a health care response to terrorism should be based on careful appraisal and prioritization of the possible chemical and biological threats and the costs of coping with them.

• Criteria should be developed to facilitate recognition of chemical and biological incidents, and existing resources should be organized to further develop technologies that allow rapid and accurate identification of chemical and biological agents.

• Procedures and algorithms for the provision of medical care within a contaminated area, triage principles to be applied in the event of mass casualties, and methods of handling patients with contaminated wounds need to be developed, particularly for dealing with chemical agents.

• Local medical and EMS personnel must be trained in the recognition and management of chemical and biological casualties. Even in Atlanta, where a number of specialized agencies were deployed locally in anticipation of a possible incident, the burden of initial response to a chemical incident would have fallen on the local EMS. The first-responders to a biological incident would have been personnel from local emergency department, primary care, and public health units.

• It is not necessary to create a new response system at the local level for dealing with chemical and biological agents. The infrastructure that already exists in most areas for responding to accidents involving hazardous materials can be extended and modified to deal with military chemical agents. Similarly, the mechanisms that currently exist for communicable disease control could be strengthened and extended to facilitate the initial identification and investigation of suspicious disease outbreaks.

• Specialized federal and military agencies will almost always be required to help local responders deal comprehensively with chemical and biological agents. These specialized agencies should develop programs and emergency response capabilities that are designed to rapidly augment local response systems. Careful planning and exercises involving both local and outside responders are required for a rapid and integrated response.

• Plans and policies for mass immunization, mass chemoprophylaxis, evacuation, public communications, and other critical public health responses are essential aspects of preparedness.

• Resources need to be available to conduct a thorough epidemiologic investigation of an incident so as to rapidly address public health concerns and ensure long-term follow-up of exposed persons.

• Policies and procedures must be developed for maximizing the safety of emergency responders, including the development of appropriate policies on immunization and chemoprophylaxis.

• Finally, an effective response must be multidisciplinary, involving clinicians, EMS personnel, laboratory workers, toxicologists, public health personnel, and others. Those providing a health response must work closely with law enforcement agencies, not only for reasons of safety but also to ensure a coordinated response.

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Reprint no. 47/1/89313

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